Oil-in-ice challenge prompts new research worldwide

Oil industry research groups from Norway and the US gathered at a workshop recently to discuss challenges and priorities related to spills in the Arctic


Much of our understanding of how oil behaves in ice has come from large-scale experiments


Researchers are looking at a number of techniques to conduct surveillance of oil in ice

Jostein Mykletun, Consul General of Norway in Houston, hosted the trans-Atlantic workshop on oil spills during this year's OTC Arctic Technology Conference. The workshop was a co-operative effort between the Research Council of Norway, the Royal Norwegian Consulate General in Houston, the International Research Institute of Stavanger (IRIS) and the SINTEF Group.

An oil spill can cause damage to the environment in variety of ways depending on many different factors: the distance of the spill from land, conditions such as the depth and temperature of the water at the spill site, weather conditions on the surface, geographical location and biodiversity, and the technology used in the response. Norway currently has several leading research groups that work with these issues on a daily basis. Most of them were represented at the workshop in Houston.

In his opening remarks, Dr Mykletun 'connected the dots' from the environmental research conducted on the Norwegian continental shelf in the early 1980s to the Norwegian Government's High North Strategy today. Although oil and gas exploration in the Arctic present new challenges with regard to safety and emergency preparedness, they also offer enormous potential for value creation in local communities as well as for Norway as a nation, Dr Mykletun said.

Invitations to the workshop were targeted to ensure that the relevant research groups from Norway and North America participated. Government authorities from both sides of the Atlantic were also represented, and the oil companies also took part and provided an outline of what they will need if they are to meet the challenges in the Arctic in the safest manner possible.

"This is a vital initiative that hopefully will expand transatlantic co-operation on oil spill preparedness," said Mike Cortez, technology manager at BP's Gulf Coast Restoration technology team. Mr Cortez said he would like to ensure that the experience from the *Deepwater Horizon* accident is incorporated into the assessment of new activities in the northern areas.

Hanne Greiff Johnsen, a principal researcher in environmental technology at Statoil in Norway, flew in from Trondheim to describe the company's challenges and priorities related to oil spill prevention and response in the Arctic. "Our goal is to create flexible systems that yield the maximum benefit for the environment," Dr Greiff Johnsen explained. "Both basic research and technological development are needed, but testing and experimentation under realistic conditions are essential as well."

As previously highlighted in *OSJ*, in 2010 a large-scale collaborative project on oil spill response in ice-covered waters was completed. In co-operation with SINTEF, several oil companies conducted studies over a period of several years on a variety of technical solutions for responding to oil spills in ice-covered waters.

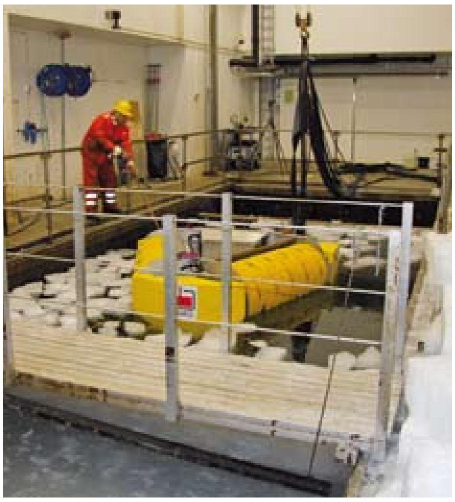
The project concluded with realistic testing of technology south of Hopen Island in the Barents Sea. The project produced a lot of new knowledge and brought to light areas that require further effort, and industry players are working together to launch another major four-year programme.

The ability to model how oil will behave in the ocean is essential for risk analysis, contingency planning and effective response to oil spills when they occur. This is a tremendous challenge, especially in waters covered with ice. Mark Reed, a senior researcher at SINTEF, put it this way: "We have not made significant progress in the past 20 years when it comes to modelling the behaviour of oil in ice-covered waters. The time is ripe for an international, co-ordinated effort."

In recent years the Research Council of Norway's large-scale Programme on the Optimal Management of Petroleum Resources (PETROMAKS) has provided funding to research groups in Norway to conduct knowledge-building projects that address this issue in various ways.

"In future, priority should be given to studying both the efficiency of the technology used to respond to an oil spill and the impact this in itself has on the environment. Research on the use of dispersants is particularly important," said Anne Hjelle, vice president of IRIS Biomiljø. "These research questions can form the basis of many exciting international projects in the years to come."

Questions such as these are being addressed in a number of programmes at the Research Council of Norway. PETROMAKS is the largest of these; another is a subprogramme on the long-term effects of discharge to the sea from petroleum-related activity (PROOFNY), which is part of the programme on the oceans and coastal areas (HAVKYST).



New oil recovery devices are being developed by industry

"The workshop was a huge success," said Siri Helle Friedemann, programme co-ordinator for PETROMAKS and acting director of the Department for Petroleum Research. "Many concrete proposals were pounded out. I was especially pleased to see industry take such an active part, discussing the challenges, priorities and opportunities related to future efforts."

As highlighted in the special supplement to the May/June 2011 issue of *OSJ* on Arctic and ice class OSVs, field experiments conducted in recent years suggest that responding to an oil spill in ice could be more difficult and technically challenging than doing so in open waters. However, experts suggest that in some cases the conditions in the Arctic might make oil spill response easier.

When presenting a paper to the OTC Arctic conference earlier this year, David Dickins, of DF Dickins Associates in Canada, said that observations from field experiments show that natural containment, reduced wave action and slower weathering in ice cover can extend the windows of opportunity and effectiveness of such operations as in-situ burning and dispersant application. At the same time, ice generally prevents the effective use of traditional mechanical clean-up methods.

Mr Dickins explained that low air and water temperatures coupled with the presence of ice can reduce the rate at which an oil slick spreads, limiting the area of contamination, and evaporation rates are reduced. As a result, lighter and more volatile components in oil remain longer, which makes it easier to ignite. Wind and sea conditions are far less severe than in most open ocean environments, thus facilitating marine operations. Ice precludes the use of conventional containment booms, but the ice itself often serves as a natural barrier to the spread of oil. The natural containment of oil herded against ice leads to thicker oil films that improve the effectiveness of in-situ burning.

Mr Dickins explained that where the concentration of ice is high, most of the spilled oil – particularly oil from a subsea blowout – will rapidly become immobilised and encapsulated within ice. Such oil is isolated from any weathering processes, and the fresh condition of the oil when exposed at a later date (through ice management or natural melt processes) enhances the chances for effective combustion. He also explained that the fringe of fast ice common to most Arctic shorelines acts as an impermeable barrier and prevents oil that has been spilled offshore from contaminating sensitive coastal areas.

Among the challenges presented by the behaviour of oil in ice, Mr Dickins highlighted the difficulty in accessing oil trapped on or under ice, especially offshore in moving pack ice, where response teams cannot safely maintain sustained operations. Other challenges include the lack of oil spreading or flowing within slush

Joint project will examine DP operations in ice

Dr James Millan, a senior research council officer at the Institute for Ocean Technology, part of the National Research Council in Canada, says he and colleagues are in the process of setting up a joint industry project (JIP) to look at another important aspect of operating in ice-covered waters: doing so using dynamic positioning.

"We are currently in the process of setting up a small JIP for this year with the various workshop attendees which is aimed at indentifying gaps in knowledge relating to station keeping in ice-covered waters," he explained.

"The aim is to complete a report this year, and to analyse and share the data that we have already collected from our in-house DP testing. This could possibly lead into a larger research programme later on that would aim to fill in the gaps."

Dr Millan recently completed a successful demonstration of DP operation in ice-covered waters, at model scale, using a completely free-running model. These arrangements removed all influences of umbilical cables or tow devices on vessel motions and showed that it was possible to keep the drillship within an acceptable watch circle. The DP system is based on nonproprietary control software that is backed by more than 10 years of development and model testing experience.

As Oceanic Consulting Corporation in Canada notes, an important advantage of an open-source DP system like this is that it becomes possible to understand the influence of internal DP control parameters on the behaviour of a ship. Furthermore the same code can be deployed in numerical simulations.

Models of the type used by Millan and his colleagues can be equipped with up to six azimuthing thrusters, plus additional fixed thrusters, and rudders. The azimuthing thrusters are instrumented to measure thrust.

Oceanic said that it sees successful application of DP in ice as "a major technological improvement" for Arctic drilling; it is working together with others in the field to develop significant collaborative research projects.

and brash-filled leads and openings in the pack ice, making skimming operations extremely difficult, and the sensitivity of oil spreading to subtle changes in floe geometry and ice coverage. He explained that the action of manoeuvring a vessel close enough to access oil may create rapid spreading of the slick into much thinner, less recoverable films.

Understanding of the important aspects of the behaviour of oil in ice "is already at a very high level", based on 40 years of research in the US, Canada and Norway. Despite this, one remaining area where the knowledge base is deficient involves the behaviour of oil under multiyear or 'old' ice, Mr Dickins noted.

"As oil and gas exploration moves into deeper water in the Beaufort Sea and off Greenland, spill scenarios involving this much thicker, less porous ice will become increasingly important," he explained.

As oil and gas operations move into the Arctic, new technology will be required

Mr Dickins ended his presentation with a note of concern about how much longer it will be possible to conduct the kind of field experiments which have yielded so much useful knowledge about oil in ice and how to tackle it.

"Much of what we have learned to date about how to deal with the possibility of Arctic oil spills can be directly attributed to the ability of researchers to conduct experimental spills. Over the past 15 years this ability has steadily eroded as the barriers to obtaining the necessary permits have become more and more onerous," he explained.

"Industry needs to find a way to work with regulators, local residents and special-interest groups to encourage future experimental spills in different regions." **OSJ**

Statoil in the Arctic

In an interesting presentation at the Houston oil spill workshop, Dr Greiff Johnson and her colleague Kathy Kanocz, head of HSE development and production North America, provided an overview of the work that Norway's state-owned oil company is doing on oil ice.

Statoil is already active or planning activity in Arctic and sub-Arctic areas such as the Snøhvit and Goliat fields, offshore Canada, East Greenland, west Greenland, Alaska and, of course, the Shtokman field and has strengthened its research effort in this area in recent years.

They explained that Statoil has a number of oil spill research and technology priorities. Among them are:

- **solutions/technologies adapted for use in cold climates (including ice), seasonal darkness and remote locations**
- **studying the environmental fate and effect of spilled oil in Arctic conditions (including impacts of different oil spill response options)**
- **oil spill trajectory modelling in the Arctic, including in ice**
- **reliable surveillance and monitoring (subsea and on surface) technology, including automatic detection of spills, and**
- **standardised methods for efficiency testing of oil spill response equipment and techniques.**

Statoil has four main oil spill response research and technology priorities, the first being enhancement to existing technology. These are broken down into:

- **mechanical recovery, including high-capacity systems for recovery, including a range of types of oil and ice scenarios; optimising the performance of components such as surface coatings and brush material; the use of dispersants (surface and sub-surface) and ways to optimise application technologies and develop and test the next generation of dispersants**
- **in-situ burning, including ignition techniques for far offshore; the use of oil 'herders' to enhance in-situ burning and its operational potential; and the development of the next generation of fire-resistant booms.**

The second major R&D area being pursued by Statoil addresses the environmental fate and effect of oil spills in Arctic conditions, including:

- **size and behaviour of dispersed oil droplets**
- **the extent of biodegradation of dispersed oil in various scenarios**
- **3D modelling of dispersed oil plumes and quantification of horizontal and vertical diffusion**
- **toxicity of dispersed oil with regard to Arctic species**
- **the efficacy of mechanically versus chemically dispersed oil**
- **acute and chronic impact studies, and**
- **validation and verification using new and existing data from laboratory and large-scale field trials.**

The third major area that Statoil is looking at is oil spill trajectory modelling in Arctic waters, including:

- **developing the capability to predict the trajectory of oil spills in Arctic waters with different ice concentrations**
- **enhancing trajectory models using updated weathering and spreading information and real-time ice monitoring**
- **developing new model algorithms**
- **incorporating existing real-time metocean data**
- **validating and verifying models using new and existing data from laboratory and large-scale field trials.**

The fourth area that the company is studying is surveillance and monitoring, including reliable automatic detection of spills and leakages. This includes:

- **surface surveillance, including visual observation, infrared (IR) techniques, radar and satellite**
- **subsea surveillance, including the use of hydrocarbon sniffers, active and passive acoustics, and visual monitoring, and**
- **development needs/challenges, such as ensuring that equipment and technology is sufficiently robust, reliable and has sufficient range.**

What is needed, said Statoil, is flexible solutions covering a wider range of oil spill scenarios, field experiments and experimental studies focusing on realistic exposure regimes, scientific documentation for decision support systems (in order to obtain maximum environmental benefit in a clean-up operation), integrated environmental monitoring supporting leak detection and the ability to conduct spill response work in all seasons and in darkness, with limited infrastructure, in remote areas, with due consideration given to worker safety.

It would be important, they noted, to emphasise a flexible combination of techniques rather than rely on containment and recovery, as is more commonly practised in temperate locations.